United States Patent [19]

Moulden

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[54] **ANTISTATIC EQUIPMENT EMPLOYING POSITIVE AND NEGATIVE ION SOURCES**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 80,272, Oct. 1, 1979.

[51] **Int. Cl.**[3] **H05F 3/06**

[52] **U.S. Cl.** **361/213;** 361/231

[58] **Field of Search** 361/212, 213, 226, 227, 361/229, 231, 235

[56] **References Cited**

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[57] **ABSTRACT**

pg,1 Apparatus for generating and dispersing ions, comprises:

(a) first and second tip means aimed generally longitudinally forwardly, said first tip means spaced laterally from said second tip means,

(b) insulative structure extending about said tip means,

(c) and circuit means to supply high voltage of relatively positive polarity to the first tip means and high voltage of relatively negative polarity to the second tip means.

The first and second tip means are typically located in insulative, parallel tubes which are endwise open and located in a surrounding tube through which gas is caused to flow.

15 Claims, 5 Drawing Figures

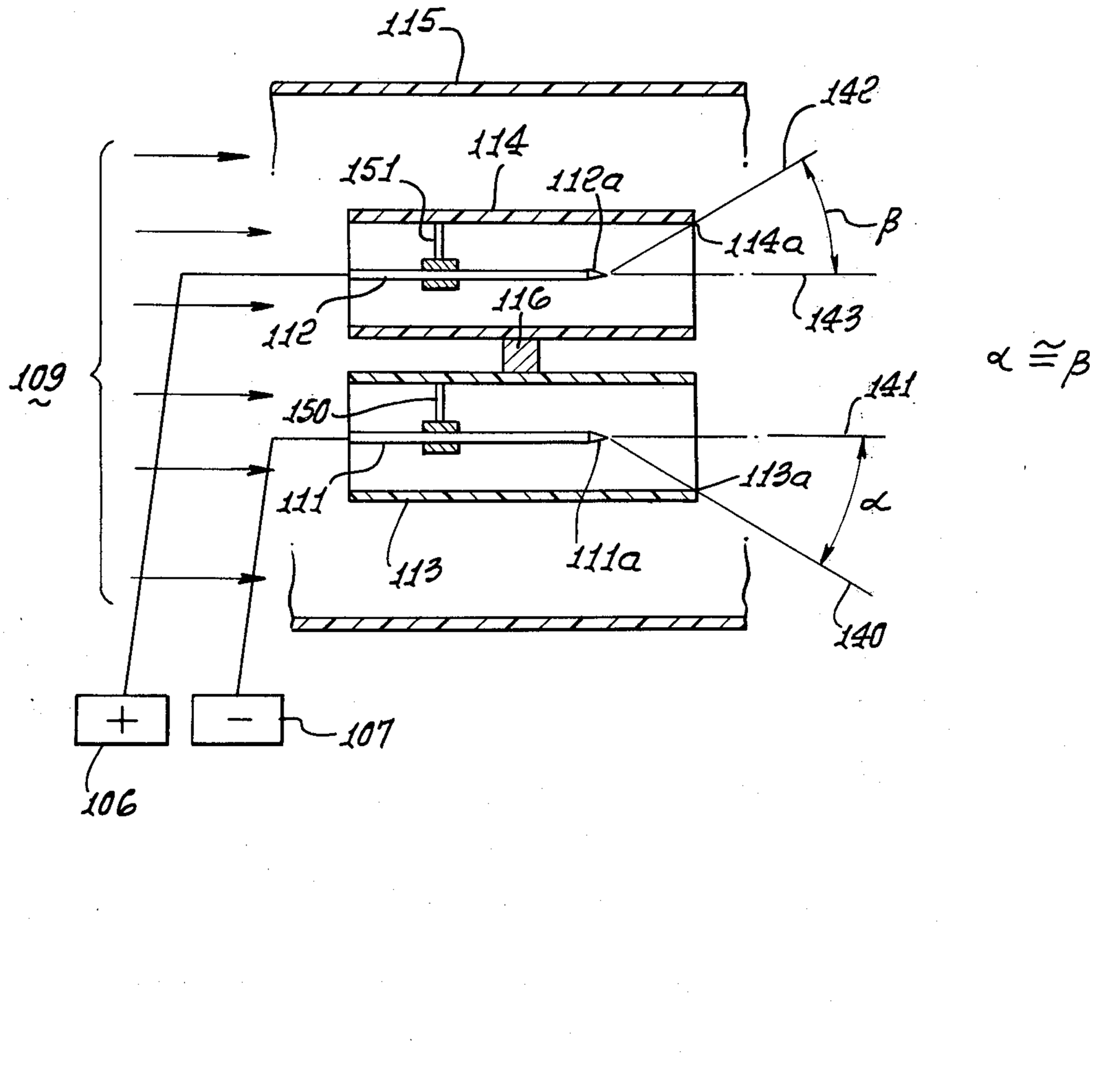


FIG. 1.

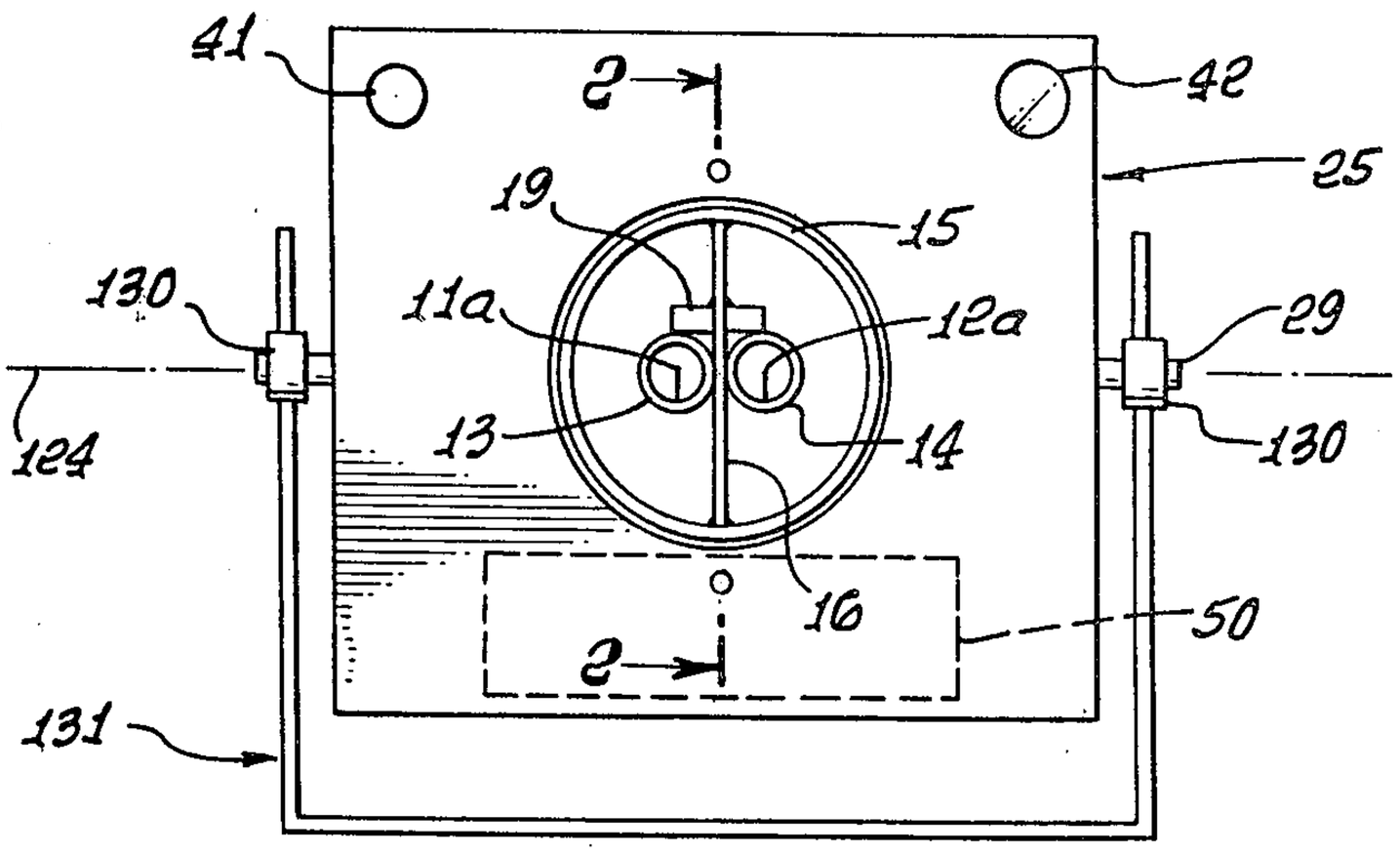


FIG. 2.

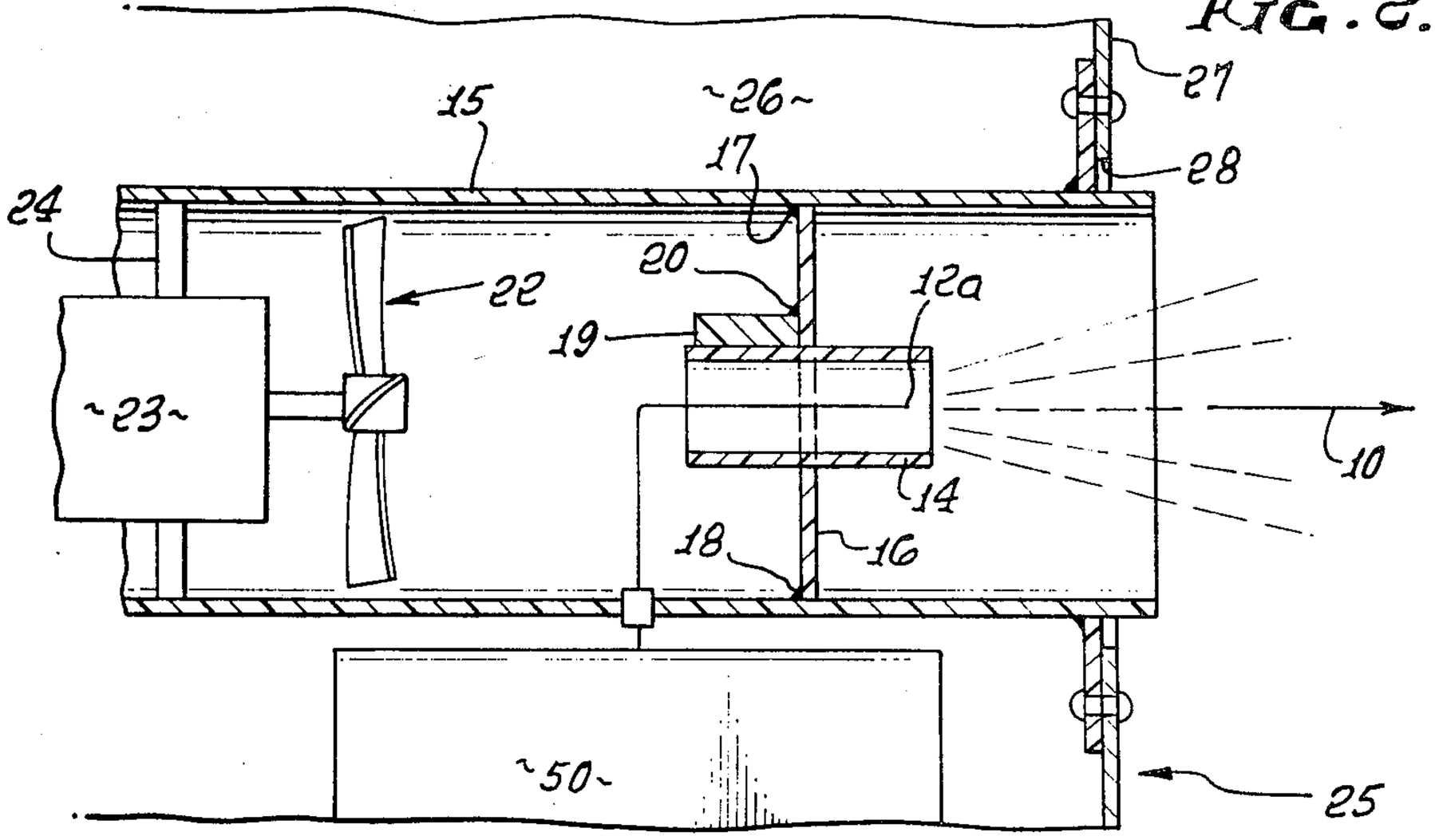


FIG. 3.

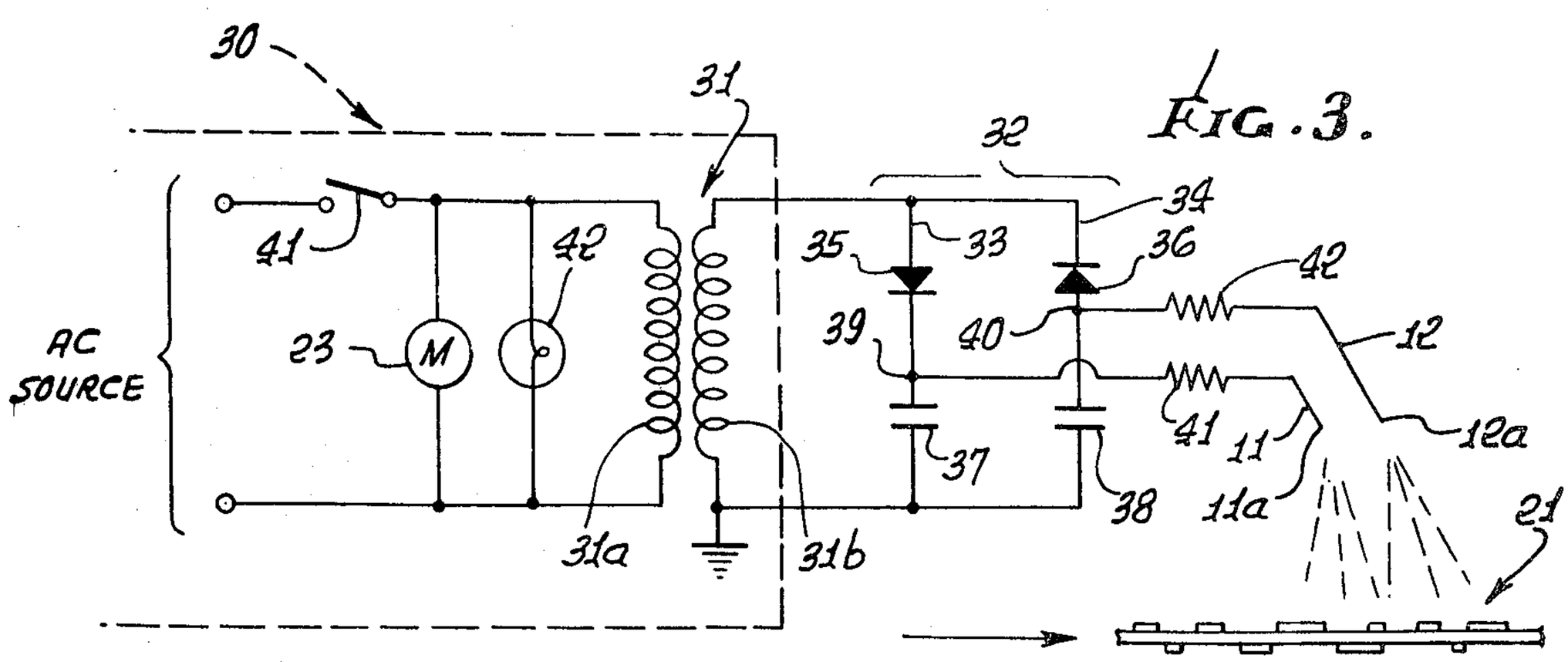
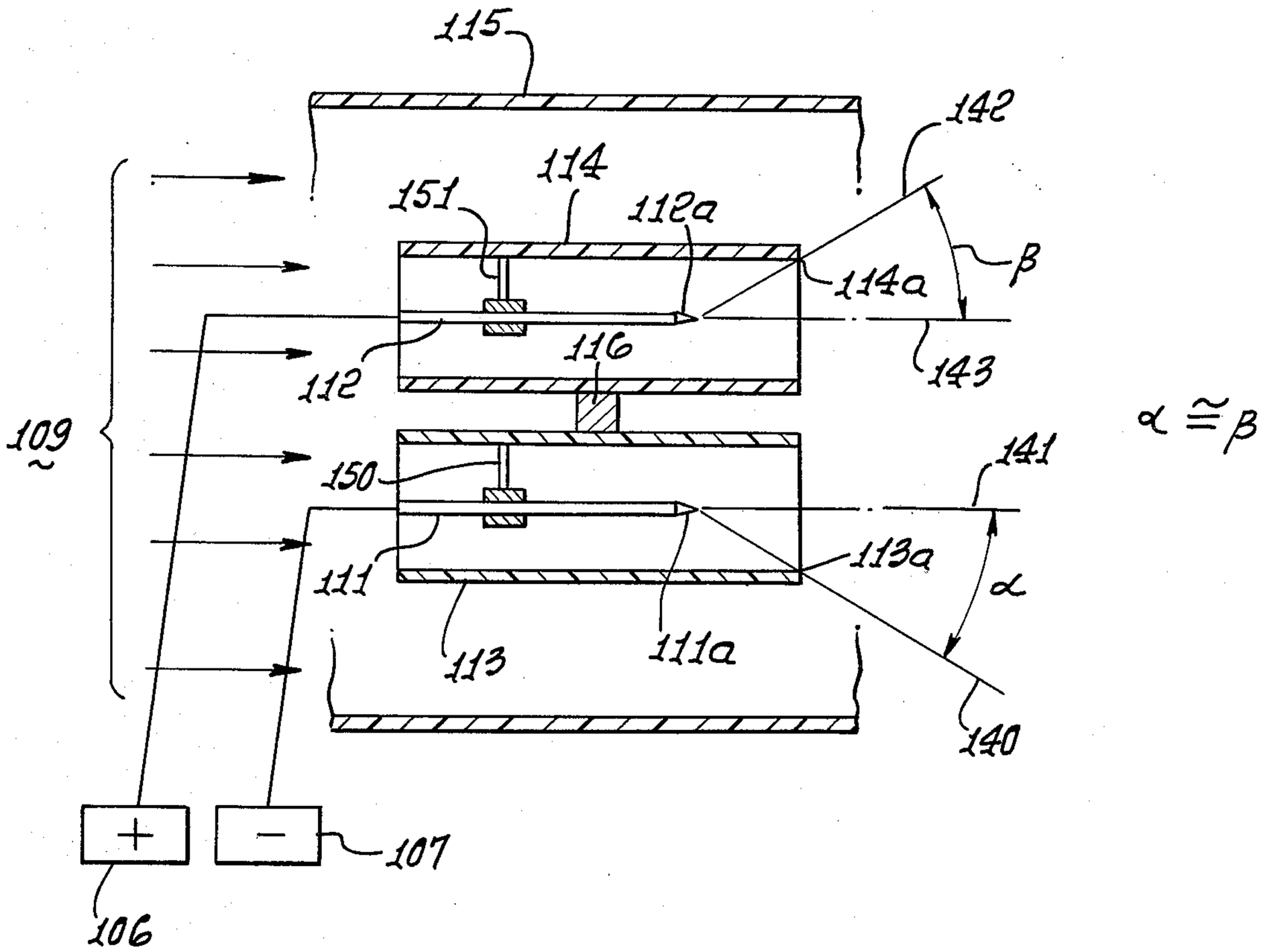
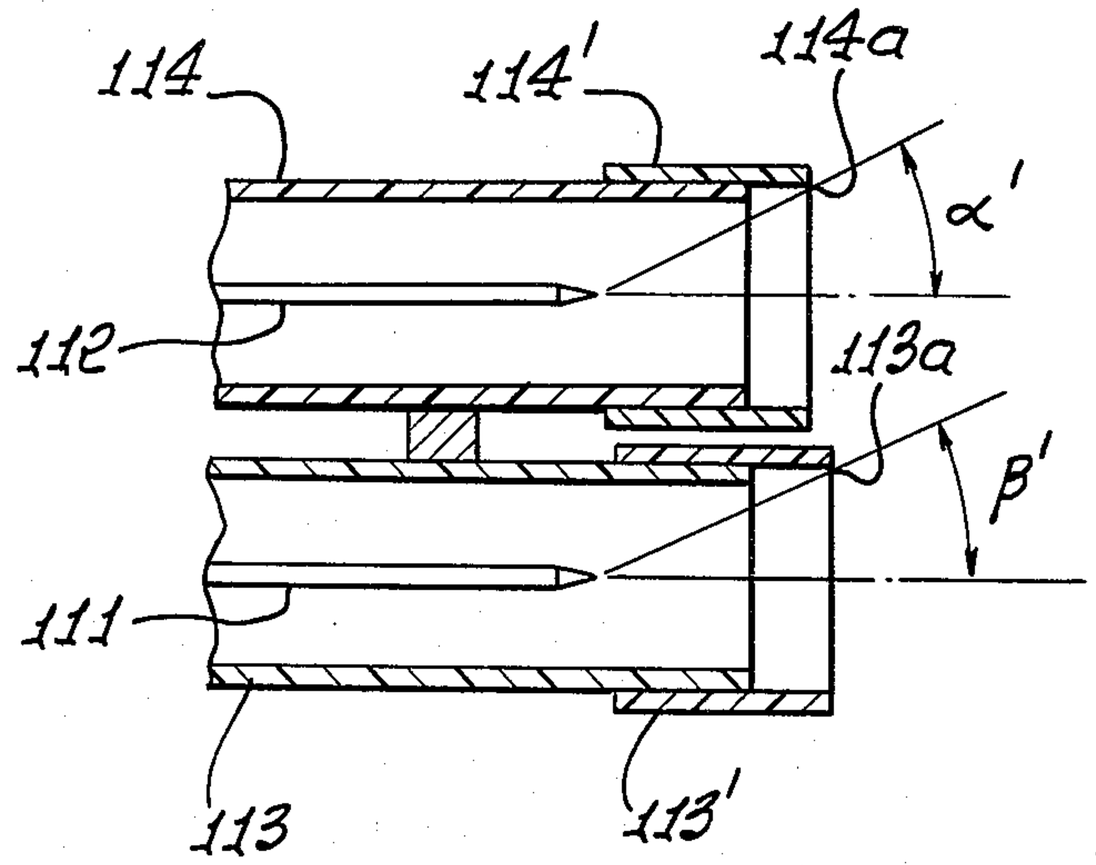


FIG. 4.



$\alpha \cong \beta$

FIG. 5.



ANTISTATIC EQUIPMENT EMPLOYING POSITIVE AND NEGATIVE ION SOURCES

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my prior application Ser. No. 80,272, filed Oct. 1, 1979.

This invention relates generally to antistatic treatment of electrically charged objects and more particularly concerns improvements in ion generation and dispensing apparatus for altering the static charge on work surfaces.

In manufacturing electrical circuit boards, it is found that static charges develop in the conductive circuitry. Such charges can and do at times injure sensitive electrical components on such boards, whereby expensive scrappings of the boards becomes necessary. Insofar, as I am aware, no way was known prior to the present invention to eliminate this problem.

SUMMARY OF THE INVENTION

It is a major object of the invention to provide apparatus and method characterized as overcoming the above described problems as well as problems with the equipment or products where electrical neutralization is necessary. Basically, the apparatus of the invention comprises:

(a) first and second tip means aimed generally longitudinally forwardly, said first tip means spaced laterally from said second tip means,

(b) insulative structure extending about said tip means,

(c) and circuit means to supply high voltage of relatively positive polarity to the first tip means and high voltage of relatively negative polarity to the second tip means.

As will appear, the circuit means may include a source of alternating high voltage, rectifiers and capacitors in parallel branches to which the tips are respectively connected and isolation resistors, the rectifiers poled to product positive voltage at one tip during one-half cycle and negative voltage at the other tip during the other half cycle; and tips are located in parallel, spaced insulative tubes or ducts which are open ended, and a larger tube or duct receives the smaller tubes all in such manner that air flow through all tubes occurs to enhance the neutralizing effect; the spacing of the tips from the forward ends of the tubes is selected of adjusted to enhance ion projection and/or to vary relative positive and negative in production; and pivoted housing structure is provided for the tubes. Accordingly, the work such as circuit boards is alternately bathed in positive and negative ions sufficiently mixed to neutralize the work.

It is another object of the invention to provide a method of generating and dispersing ions for electrically neutralizing articles, and employing tips means as referred to, the method including the steps:

(a) supplying high voltage of relatively positive polarity to the first tip means during first time intervals to generate positive ions, and

(b) supplying high voltage of relatively negative polarity to the second tip means during second time intervals to generate negative ions,

(c) said first and second time intervals occurring in alternating sequence, and

(d) causing said ions to travel onto at least one of said articles.

Further, the articles may comprise circuit boards having electrical components which become statically neutralized; enhancement of neutralization is achieved by flowing gas such as air forwardly about the tips and toward the article or articles, and the positive and negative voltages are approximately equal in absolute value, for neutralization purposes.

The invention improves over the devices described in U.S. Pat. Nos. 3,308,344 to Smith et al, and 3,976,916 to Saurenman.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following description and drawings in which:

DRAWING DESCRIPTION

FIG. **1** is a frontal view of apparatus incorporating the invention;

FIG. **2** is an enlarged vertical section on lines **2—2** of FIG. **1**;

FIG. **3** is a circuit diagram; and

FIGS. **4** and **5** are plan views showing modifications.

DETAILED DESCRIPTION

In accordance with the invention, first and second tip means are provided, to be aimed generally longitudinally forwardly (see arrow **10** in FIG. **2**). In the illustrated embodiment, the first and second tip means take the form of first and second tips **11***a* and **12***a* respectively at the forward ends of longitudinally elongated needles **11** and **12**. The two needles, and their associated tips are laterally spaced apart so that ions of differing polarity may be delivered therefrom, in alternating sequence, with minimum interference.

Insulative structure extends about the tip means, and in the example shown takes the form of first and second generally parallel, forwardly elongated plastic tubes **13** and **14** respectively extending about the first and second tips **11***a* and **12***a,* as well as about needles **11** and **12**. Note that the tips are spaced inwardly from the forward ends of the tubes, for protection and for minimizing mutual interference as respects ion delivery. An outer and larger diameter plastic tube **15** extends about the two smaller tubes, and is also open ended. A vertical strut **16** extends diametrically across the bore of the outer tube and is attached thereto at **17** and **18**. A horizontal strap **19** is attached at **20** to the strut, and also to the tops of the two smaller tubes, to support them near the center of the larger tube. Strut **16** extends between the smaller tubes, as seen in FIG. **1**. This construction facilitates optimum air flow forwardly through all the tubes, as described below. Insulative tubes **13, 14** and **15** may consist of polyvinyl chloride.

Means is also provided to supply flowing gas (such as air) to pass forwardly through the tubes **13–15**, thereby to aid in transporting the charged ions, generated by the tips **11***a* and **12***a,* beyond the tubes and onto work such as circuit boards indicated at **21** in FIG. **3**. Such means is shown in FIG. **2** to include a fan **22** supported and driven to rotate in outer tube **15** by an electric motor **23**. The latter may be suitably supported at **24** by tube **15**, to provide a very simple and effective construction in combination with all three tubes **13–15**. The open-endedness of all the tubes facilitates air flow through and about tubes **13** and **14** to optimally maintain the flow of ions directed toward and onto the work.

Further as appears in FIGS. 1 and 2, structure is provided to pivotally support the outer tube **15** so that the latter and tubes **13** and **14** may pivot as a unit about an axis **124** generally normal to the longitudinal direction **10**. As shown, such structure advantageously includes a housing **25** defining an interior zone **26** in which the tubes **13–15** are located, the housing having a front wall **27** with a through opening **28** in alignment with the outer tube **15** and parallel tubes **13** and **14**. Support means including trunnions **29** on the housing side walls and bearings **130** on a bracket **131** pivotally support the housing to pivot about horizontal axis **124**, whereby the ion generally tips **11***a* and **12***a* and associated tubes **13–15** may be selectively aimed at work such as the circuit boards **21**. As will be seen, ions of alternately negative and positive polarity may thus be caused to flow onto the circuit board, or boards, to electrically neutralize same.

Further in accordance with the invention, circuit means is provided to supply high voltage of relatively positive polarity to one tip, and high voltage of relatively negative polarity, to the other tip. An example of such circuit means is shown in FIG. **3** to include a source **30** of alternating voltage. That source may comprise an AC, 115 volt, 60 cycle source, and a transformer **31** having a primary coil **31***a* connected across that source. High voltage derived from the secondary coil **31***b* is applied through the circuitry **32** to the two tips **11***a* and **12***a*. Such circuitry includes parallel branches **33** and **34** connected in series with coil **31***b*, a first rectifier (as for example a diode) **35** connected in one branch **33**, and a second rectifier (as for example a reversed) diode **36** connected in the other branch **34**. The first branch **33** also includes first capacitance **37** connected in series with rectifier **35**, and the second branch includes second capacitance **38** connected in series with the second rectifier **36**. The first tip **11***a* and needle **11** are connected to the first branch at **39** between the rectifier **35** and capacitor **37**; and the second tip **12***a* and needle **12** are connected to the second branch at **40** between rectifier **36** and capacitor **38**. The circuit means also includes isolation resistances **41** and **42** respectively connected between point **39** and needle **11**, and between point **40** and needle **12**. As an example, when about 3800 VAC is developed across secondary coil **31***b*, about 6,000 volts positive is developed during one-half cycle at tip **11***a*, and about 6,000 volts negative is developed during the other half cycle at tip **12***a*, with circuit elements having values as follows:

	value or identification
diodes	
35	High voltage rectifier 10,000 PRV, 25 miliamps
36	High voltage rectifier 10,000 PRV, 25 miliamps
capacitors	
37	.01 MFD.
38	.01 MFD.
resistance	
41	22 meg ½ Watt
42	22 meg ½ Watt or vary to equalize voltage output

It is found the invention enables electrical neutralization of the components of circuit boards, to eliminate or prevent build-up of static charges that would harm, or interfere with operation of circuit board components.

The circuitry **30**, **31** and **32** of FIG. **3** is conveniently contained within zone **50** in the housing. An on-off switch **41** is located on the front wall **27** of the housing; and an on-off indicator light **42** is also located on that front wall. Motor **23** may be electrically connected across the AC source, as shown in FIG. **3**. Diodes **35** and **36** are oppositely poled, as shown.

In the plan view of FIG. **4**, the tubes **113** and **114** correspond to tubes **13** and **14** above, and large diameter tube **115** corresponds to large diameter tube **15**, above. Needles **111** and **112** in the tubes project axially forwardly, and they have tips **111***a* and **112***a*. The tubes have forward ends **113***a* and **114***a* which are circular and spaced forwardly of the tips. In this regard, the tips are located sufficiently rearwardly of the tube forward ends as to optimize, or nearly optimize ion projection forwardly from the needles. Forward air streams through tubes are indicated at **109**. A tube mounting strut **116** corresponds to strut **16**. Sources of positive and negative voltage appear at **106** and **107**, and are connected to the needles as shown. They may take the form of the means described in FIG. **3**. Tubes **113**, **114** and **115** may consist of insulative plastic material.

More specifically, a line **140** extending from the first tip **111***a* to forward edge **113***a* defines an angle α with the axis **141** of the first tube **113**. Similarly, a line **142** extending from the second tip **112***a* to forward edge **114***a* defines an angle β with the axis **143** of the second tube. Each of the angles α and β is less than about 45° and preferably is between about 30° and 40° for best results in terms of ion production.

Further, the needles and their tips are supported within the tubes, as for example by supports **150** and **151**. One or both of the latter may allow adjustment of the supported needle or needles in an axial direction, to vary the spacing of the tip or tips from the forward end or ends of the tubes. Accordingly, for example, if the amount of negative ions produced by tip **111***a* is too great in relation to the amount of positive ions produced by tip **112***a*, tip **111***a* may be adjustably displaced forwardly to decrease its negative ion production. Conversely, tip **112***a* may be adjustably displaced forwardly to decrease positive ion production if that result is desired. Thus, the relative intensities of positive and negative ion production or dispersal by the tips have an adjustably selected or selectable relationship.

FIG. **5** shows that a similar or the same result can be achieved by adjusting the position of the tube forwardmost ends relative to the tips, which have fixed positions. Note sleeves **113'** and **114'** on the tubes, defining edges **113***a* and **114***a*. The sleeves are slidably adjustable on the tubes, as shown.

I claim:

1. In apparatus for generating and dispersing ions,

(a) first and second tip means aimed generally longitudinally forwardly, said first tip means spaced laterally from said second tip means,

(b) insulative structure including first and second generally parallel tubes respectively extending about said first and second tip means,

(c) circuit means to supply high voltage of relatively positive polarity to the first tip means and high voltage of relatively negative polarity to the second tip means,

(d) said tubes having forward ends which are spaced forwardly of said first and second tip means, and

(e) means supporting said tip means to extend within said tubes, at least one of the tip means adjusted spacially relative to the forward end of the tube within which it extends whereby the relative intensities of the positive and negative ions dispersed by

the tip means have an adjustably selected relationship.

2. The apparatus of claim 1 wherein said circuit means includes a source of alternating high voltage, first rectifier means connected between said source and said first tip means, and second rectifier means connected between said source and said second tip means.

3. The apparatus of claim 2 wherein said source includes a transformer having a secondary coil, and said circuit means includes parallel branches connected in series with said secondary coil, the first rectifier means connected in one of said branches and the second rectifier means connected in the other of said branches.

4. The apparatus of claim 3 wherein the first branch includes first capacitance connected in series with the first rectifier means, and the second branch includes second capacitance connected in series with the second rectifier means, the first tip means is connected to said first branch between the first rectifier means and the first capacitance, and the second tip means is connected to the second branch between the second rectifier means and the second capacitance.

5. The apparatus of claim 2 wherein said circuit means includes resistance connected with said tip means to control the voltages at said tip means.

6. The apparatus of claim 4 wherein the source means includes a transformer having a secondary coil operatively connected with said first and second rectifier means to supply at least about 6,000 peak positive volts to said first tip means and to supply at least about 6,000 peak negative volts to said second tip means.

7. The combination that includes the apparatus of claim 1 and a circuit board at which said tip means are aimed to direct positive and negative ions onto the board to electrostatically neutralize same.

8. The apparatus of claim 1 wherein a line extending from the first tip means to the forward edge of the first tube defines an angle α with the axis of the first tube, said angle α being less than about 45°.

9. The apparatus of claim 8 wherein a line extending from the second tip means to the forward edge of the second tube defines an angle β with the axis of the second tube, said angle β being less than about 45°.

10. In apparatus for generating and dispersing ions,

(a) first and second tip means aimed generally longitudinally forwardly, said first tip means spaced laterally from said second tip means,

(b) insulative structure including first and second generally parallel tubes respectively extending about said first and second tip means, said tubes being endwise open, and including means to supply flowing gas to flow forwardly through said tubes,

(c) circuit means to supply high voltage of relatively positive polarity to the first tip means and high voltage of relatively negative polarity to the second tip means,

(d) and an outer tube extending about both of said generally parallel tubes and to which flowing gas is supplied to flow forwardly about said generally parallel tubes.

11. The apparatus of claim 10 wherein said means to supply flowing gas comprises a motor driven fan in gas flow transmitting spaced relation to rearward open ends of said parallel tubes.

12. The apparatus of claim 10 including structure pivotally supporting said outer tube, said parallel tubes and said tip means to pivot as a unit about an axis generally normal to said longitudinal direction.

13. The apparatus of claim 12 wherein said structure includes a housing defining an interior zone in which said outer tube, said parallel tubes and said tip means are located, said housing having a front opening in alignment with said outer tube, said parallel tubes and said tip means, and support means pivotally supporting the housing to pivot about said axis.

14. The apparatus of claim 10 wherein said tubes have forward ends which are spaced forwardly of said first and second tip means.

15. The apparatus of claim 14 wherein the tubes have forwardly extending central axes, the tip means located proximate said axes.

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